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Building The Wireless Future

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Randall S. Coleman
Vice President for Regulatory Policy and Law

May 3, 1996

Mr. William F. Caton
Secretary
Federal Communications Commission
1919 M Street, NW, Room 222
Washington, DC 20554

Re: Ex Parte Presentation Concerning CC Docket No. 95-185
(Interconnection Between Local Exchange Carriers and Commercial Mobile Radio Services Providers

Dear Mr. Caton:

On May 2, 1996, Messrs. Thomas E. Wheeler, Brian F. Fontes and Randall Coleman, all of CTIA, and Mr. Steven R. Brenner of Charles River Associates, met with Commissioner James H. Quello and Ms. Lauren J. Belvin and Mr. Rudolfo M. Baca of Commissioner Quello's office. The discussion concerned the compensation arrangements for interconnection between local exchange carriers and providers of Commercial Mobile Radio Services. The views expressed in this meeting reflect CTIA's positions as previously filed in this proceeding. Copies of the attached materials were left with Commissioner Quello. Ms. Belvin and Mr. Baca.

Pursuant to Section 1.1206(a)(1) of the Commission's Rules, an original and one copy of this letter are being filed with your office. Please contact me if you have any questions concerning this submission.

Sincerely,

Randall S. Coleman

Attachments (3)

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Economic Aspects of Reciprocal Termination

- Both theory and evidence indicate that negotiated compensation arrangements are likely to reflect the superior bargaining power of the wireline carrier and to be inefficient.

- Reciprocal termination arrangements impose costs on both carriers; neither the wireless nor the wireline carrier receives termination services for free under reciprocal termination arrangements.

- The relative amount of traffic each carrier terminates is not a reliable indicator of the cost each carrier bears under reciprocal termination arrangements.

- *Neither* reciprocal termination, *nor* any feasible plan charging for terminating usage, will send completely efficient price signals to the market; this is not a policy choice between efficient and inefficient pricing plans.

- Reciprocal termination may send pricing signals no less efficient than those of plans charging for terminating usage, and will save billing and other transaction costs.

- Reciprocal termination arrangements reduce the risk that interconnection arrangements will limit the development of competition between wireless and wireline carriers.

Summary Prepared by CTIA of:

ECONOMIC ISSUES IN THE CHOICE OF COMPENSATION ARRANGEMENTS FOR INTERCONNECTION BETWEEN LOCAL EXCHANGE CARRIERS AND COMMERCIAL MOBILE RADIO SERVICE PROVIDERS

(Steven R. Brenner/Bridger M. Mitchell--Charles River Associates)

I. INTRODUCTION.

II. NEGOTIATED AGREEMENTS.

Interconnection agreements negotiated between LECs and CMRS providers without regulatory intervention are unlikely to be efficient and in consumers' interests because the parties have unequal bargaining positions, and because LECs have an incentive to use the pricing of interconnection to extend or protect their market position. (4) The bargaining position of LECs is stronger because they can connect a far higher proportion of calls to and from their subscribers without interconnection than can CMRS providers. (4-6) A failure to reach agreement would hurt CMRS providers more than LECs. (6-7)

To the extent that LECs and CMRS providers compete in the same downstream markets for local telecommunications service, LECs have a further incentive to use interconnection arrangements to inflate CMRS costs in order to disadvantage their rival. (7) CMRS providers could be disadvantaged by the LEC charging a higher rate per minute to terminate CMRS traffic than it pays the CMRS provider to terminate LEC originated traffic. (7-8) Even if the LEC and CMRS provider pay each other the same rate per minute, a high rate will raise CMRS costs of serving a customer more than LEC costs; CMRS providers must rely on interconnection to terminate a much higher proportion of calls because a much higher proportion of the end users its customers call will subscribe to the other network. (8)

Data collected by a survey of CTIA members on current interconnection arrangements is consistent with this analysis. (8) Only ten percent of responding cellular operators said they received any payments for terminating LEC traffic, although all must pay the LEC to terminate traffic. (8) Some operators reported they in fact have to pay the LEC for the right to terminate LEC-originated traffic. (8)

III. RECOVERY OF COSTS.

A. Recovery of Costs with Usage Sensitive Payments.

With usage sensitive payments, each carrier pays directly for termination of traffic it delivers to the other carrier. (9) If the structure of rates paid does not match the structure of costs for terminating the traffic, there will be a growing divergence over time between the

amount the originating carrier pays and the amount it costs the other carrier to terminate the traffic (10).

B. Recovery of Costs Under Bill and Keep.

1. LEC and CMRS Cost Obligations.

Under bill and keep, LECs and CMRS providers each incur cost obligations in exchange for the interconnection services they receive. (11) Carriers make no payments to each other, but each bears the cost of terminating traffic from the other in exchange for receiving termination of traffic it originates; carriers do not receive termination services for free. (11)

2. Balance of Traffic.

Traffic flows between carriers need not be equal for each provider to bear equal costs under bill and keep. (12) Most of the costs of terminating traffic are costs of building sufficient capacity to carry additional interconnected traffic. (12) Only additional traffic received in the busiest hour requires adding capacity and imposes costs. (12) Terminating traffic delivered outside the busy hour will have little effect on needed capacity and therefore little effect on costs. (12) Thus it is the relative amount of interconnected traffic each carrier receives in its busy hour that affects the balance of cost, not the balance of overall traffic. (12) This busy hour traffic may be more balanced than total traffic flows, because of differences in the ratio of total traffic to traffic in the busy hour, or because a carrier receives less interconnected traffic in its busy hour than at another time. (12-13)

3. LEC-CMRS Traffic Patterns.

Data from CTIA members indicate that cellular systems and LECs may have different system busy hours. A composite traffic profile of cellular systems constructed from responses shows a system busy hour of 4-5 PM. (14) Our understanding is that many LECs have system busy hours in the late morning or early afternoon. (15) Responses also indicate that total traffic is nearly 12 times busy hour traffic for cellular systems, compared to total traffic roughly 8 - 10 times busy hour traffic for LECs. (16)

Cellular systems on average sent about three times as much total traffic to LECs for termination as they received from LECs for termination, according to responses from CTIA members. (16-17) Other evidence on traffic patterns, however, suggests that the volume of interconnected traffic CMRS providers and LECs terminate in their busy hour and that generate costs may be less unbalanced. (17)

Direct information on busy hour traffic volume balance is not available. (17) Three illustrative, indirect calculations, based on limited traffic profile information from CTIA members, indicate how the flows of total and busy hour traffic may differ. (17) In the first adjustment, because of non-coincident busy hours, LECs receive the largest hourly volume of traffic for termination outside their busy hour, when additional traffic does not require additions

to capacity; during the busy hour, when additional traffic does impose capacity costs, LEC receive only 85% of the maximum flow. (17-18) If the ratio of total CMRS-terminated to total LEC-terminated traffic is 1:3, the ratio of CMRS to LEC traffic terminated in the busy hour of each carrier would be 1:2.55. (18) In the second adjustment, the ratios of total traffic to traffic in the busiest hour differ for LECs and CMRS providers; CMRS-originated traffic is spread more evenly across 24 hours than is LEC traffic, so total traffic is 11.6 times busy hour traffic for CMRS providers and only 8 times busy hour traffic for LECs. (18) Adjusting for this difference, the ratio of CMRS to LEC traffic terminated in each's busy hour is 1:2.1, rather than the 1:3 ratio of total traffic. (18) Combining these two adjustments results in a ratio of CMRS-terminated to LEC-terminated traffic in each's busy hour of 1:1.76. (18)

The traffic data discussed to this point are for current cellular systems. (19) Termination traffic should be increasingly balanced between LEC and CMRS as the two become better substitutes, and with various technological improvements and marketing practices such as lower power handsets, increased battery life, caller identification, and free first minutes of incoming calls. (19-20) American Personal Communications (operating as Sprint Spectrum), which offers such features, reports a 50-50 balance of calls exchanged between itself and the LEC in its area. (20)

4. Cost of Added Capacity.

The costs of LECs and CMRS providers under bill and keep will depend not only on how much traffic each terminates during its busy hour, but also on the cost of adding capacity for an additional minute of traffic. (20) The structure of LEC and CMRS networks differ, and thus their costs per minute for additional traffic may differ, which could offset an imbalance in the volume of traffic each terminates. (20)

IV. EVALUATING COMPENSATION ARRANGEMENTS.

Compensation arrangements affect economic efficiency and benefits to consumers in three ways. (20) The level and structure of prices send market signals that shape behavior. (20) Arrangements require mechanisms for monitoring, billing, and collecting for services provided that may be more or less costly. (20) Compensation arrangements and the pricing of service can affect the development of competition over time. (20)

V. EFFICIENCY OF PRICE SIGNALS.

Market prices do their job of directing the allocation of resources best when they reflect the level and structure of costs. (21) The simple case sometimes made against bill and keep is that it sets a price of zero on additional traffic sent for termination, and this price is inefficient because terminating additional traffic is costly. (21) In contrast, claims this simple argument, it is efficient to recover interconnection costs with a price on interconnected traffic that does reflect the cost of handling additional traffic. (21) This argument fails because it is too simple and incomplete. (22)

A. The Structure of Interconnection Costs.

The costs of dedicated trunks interconnecting networks should be distinguished from the costs of network facilities whose use is shared by interconnected traffic and other traffic on the network.

1. Costs of Dedicated Facilities.

The costs of facilities dedicated to interconnected traffic depend on the capacity needed and should be recovered by charges that depend directly on the capacity used. (23) Usage sensitive prices are inefficient because changes in traffic affect cost only if they require a change in capacity. (23) Where trunks carry traffic in both directions, the carriers should share the capacity costs. (23) The shares could be determined by proportionate use, or by "meet point" payment obligations, with the latter potentially saving monitoring and billing costs. (23)

2. Shared Terminating Network Costs.

The costs of network switch and trunk facilities whose use is shared by many types of traffic also depend on the amount of capacity needed to handle traffic. (24) Thus costs are driven by the volume of traffic in the busy hour, not by total traffic. (24)

B. Matching the Structure of Prices and Costs.

The efficiency of usage sensitive prices and of bill and keep is analyzed. (25) To focus on issues of price structure and present the most favorable case for usage sensitive pricing, the discussion assumes that the level of prices matches the level of costs; there will be additional inefficiencies if the price level exceeds cost. (25)

1. Derivation of Cost-based Prices.

Facility costs include the purchase and installation of various trunks and switches, and can be annualized using depreciation and discount rates. (26) These can be converted to usage based prices by first adding expenses (such as maintenance), and then dividing total annualized costs by annual billed usage (total annual usage if billing for all usage, total peak annual usage if only billing for peak usage). (26)

2. "Optimal" Pricing.

To send optimal, efficient signals to the market, price should be set at zero throughout much of the day when additional interconnected traffic requires no increase in network capacity. (27) Prices should be charged during the few hours when traffic does impose cost, but these prices should *differ* hour by hour, depending on the strength of demand and the extent to which a high price at one time would shift usage to another time (the phenomenon known as "peak shifting"). (27-28)

3. Uniform Price per Minute Compared to Bill and Keep.

Neither uniform usage prices nor bill and keep set prices that match this optimal structure. (30)

Uniform Price Per Minute:

A uniform price per minute will be too high for most traffic, which does not affect needed network capacity, and will be too low for all or most traffic that does impose capacity costs. (31) Both generate deadweight loss inefficiencies: prices that are too high discourage additional calling that would impose no costs, and prices that are too low encourage calling whose cost exceeds its value to consumers. (31)

Bill and Keep

Bill and keep's interconnection price of zero sends optimal, or near-optimal signals for most of the day when additional interconnected traffic would not strain capacity of the terminating network. (31-32) Bill and keep's price of zero is too low for busy hour traffic, and is further from optimal levels for this traffic than a uniform usage price. (32)

Neither bill and keep nor uniform pricing is fully optimal, and detailed cost and demand information would be needed to determine which sends more efficient price signals. (33)

4. Bill and Keep versus Peak/Off Peak Usage Pricing.

Theoretically optimal prices, with varying prices throughout a very limited peak period, are not feasible or advisable in practice because of the cost of implementing such prices and collecting the revenues, and because consumers likely would be confused and find it difficult to make informed usage decisions. (34) Setting different prices for each of two or three pricing periods may be feasible. (34) Such peak/off-peak pricing still will not be optimal, but if properly designed should send more efficient signals than uniform prices. (34) Peak/off-peak pricing may or may not send more efficient signals than bill and keep arrangements. (35)

5. Level of Pricing.

Regardless of the structure of prices, setting the price level too high will increase inefficiency. (36) Interconnection pricing as far above cost as interstate switched access charges would impose efficiency losses. (36) (This is discussed in more detail below.)

VI. THE EFFECT OF THE COMPENSATION ARRANGEMENTS ON TRANSACTION COSTS.

A. Tradeoffs: Triangles and Rectangles

Overall efficiency also requires minimizing the cost of production. (36) Sometimes, it is impossible to both minimize cost and obtain efficient price signals, e.g., if more efficient price structures require additional monitoring and billing costs and thus conflict with the goal of minimizing costs. (36-37)

B. Costs with Bill and Keep and Usage Sensitive Pricing.

Usage sensitive compensation arrangements unquestionably will impose higher transaction costs than bill and keep arrangements, although it is not clear that incurring these costs will necessarily lead to more efficient pricing signals. (38) CTIA survey responses detail various administrative costs that would be avoided under a bill and keep system. (39) Some systems do not have the ability to measure traffic received from LECs and adding this capability would involve a significant expense. (39) Many transactions costs involve upfront payments, for participation in regulatory proceedings, for developing billing procedures or software, for training personnel, or for equipment purchases, especially for new mobile services --none of which can be undone. (39)

VII. Effects on Competition and Dynamic Efficiency.

Dynamic changes in the range of services provided and in the extent of competition are critical for long-term improvements in overall economic efficiency and the benefits consumers receive from telecommunications services. (40) Greater competition increases efficiency and benefits consumers of both incumbent and new carriers three ways: by limiting the ability of individual suppliers to exercise market power and lowering the prices consumers must pay, by putting increased pressure on suppliers to find ways to reduce costs, and by increasing supplier incentives to innovate and improve service quality. (40) Consumers also benefit from dynamic efficiency when new services are complements to existing services that increase the demand from existing suppliers, thus moving out the demand curve. (40)

A. Effects on Entry and Competition.

The competitive significance of interconnection and its costs rests on the strongly asymmetric importance of interconnection costs for LECs and for CMRS and other local providers. (40) So long as a CMRS provider or other competing local carrier has relatively few subscribers, a high proportion of the calls its subscribers place will have to be terminated off their networks by the LECs. (41) Conversely, a high proportion of the calls placed by LEC subscribers will remain on that network, going to other LEC subscribers, and only a small proportion will terminate to the relatively small number of subscribers served by other providers. (41) Thus interconnection services will be a very important input for CMRS providers and its price will have a substantial effect on the total costs of service. (41) LECs will rely much less on purchased interconnection service and much more on self-supplied termination used for on-net calls, giving the price of purchased interconnection a much smaller impact on LEC total cost. (41-42)

Consequently the price for interconnection services will have a crucial effect on competition between LECs and new service providers. (42) New providers, whose overall costs will depend much more on interconnection prices, can be deterred from entering the market or from providing effective competition if they have to pay inflated interconnection prices. (42)

Alternatively, high interconnection prices may not prevent mobile services from being viable, but instead confine them solely to complementing LEC wireline service rather than also serving as substitutes. (42) Service prices will be inflated, entry of new mobile providers will be deterred, and CMRS will not be able to put competitive pressure on the LECs. (42)

While interconnection prices under any scheme need not necessarily be set too high, bill and keep reduces the risk that they will be set too high or incorrectly. (43) The cost to carriers of interconnection service under bill and keep does not depend on regulatory authorities having correct information and making difficult decisions, and bill and keep can be put in place quickly. (43) Under bill and keep each provider can control interconnection costs by handling terminating traffic in the most efficient way and at the lowest possible cost. (43)

With usage sensitive pricing, the risk that interconnection will be made too costly to carriers is increased. The unequal bargaining power of LECs and CMRS providers creates this risk for negotiated interconnection prices. (43) The incentive of LECs to set high interconnection prices to disadvantage competing suppliers, even when regulation forces both carriers to pay the same price, reinforces this risk. (43)

Regulation reduces but does not eliminate the risk of excessive prices and costs. (43) Regulators must collect information on costs to insure rates are not too high, and will have to rely in part on LECs for this information. (44) LECs will have an incentive (for the above reasons) to claim inflated costs for terminating traffic in order to justify higher rates. (44) Collecting information from CMRS providers imposes costs on these carriers and increases the cost of market entry. (44) CMRS participation in the necessary regulatory proceedings imposes a cost on them that is larger relative to their overall costs than it does on LECs proportionate to overall LEC costs. (44) Finally, any delays in collecting the necessary data and making regulatory decisions, increases the uncertainty and risk faced by new market entrants and will likely reduce or delay investments in expanded capacity by new carriers. (44)

B. The Structure of Interconnection Pricing and Retail Pricing.

The price a carrier pays for interconnection service becomes part of its cost structure, which in turn affects the structure of its retail prices. (44) Because a higher proportion of CMRS overall costs depends on interconnection rates, CMRS retail price structures will be more influenced by the structure of interconnection pricing than will the retail pricing of LECs. (44)

Competition will be less able to generate efficiencies by pushing retail price structures closer to the structure of costs if the structure of wholesale interconnection prices does not reflect the cost structure. (45) Thus, the discussion in V.B.3. comparing usage sensitive pricing models to bill and keep systems becomes relevant to retail pricing and competition. (46)

Setting fairly uniform usage sensitive prices of interconnection will make the costs of CMRS carriers more usage sensitive than the costs of LECs, who rely more on self-supplied termination whose costs are driven by capacity. (46-47) If the level of interconnection prices does not on average exceed cost, the levels of CMRS and LEC costs may not be distorted, but the structure of the two carriers' costs and retail prices would be distorted. (46) That in turn would distort the ability of the carriers to compete for particular customers with particular usage patterns. (46) In addition, usage sensitive interconnection pricing will make it less profitable for CMRS providers to set flat rates or other retail pricing plans with reduced usage sensitivity. If consumers prefer such pricing plans, or collecting usage sensitive charges is costly, the distortion of retail rate structure would put CMRS providers at a more general competitive disadvantage. (47)

VIII. CONCLUSIONS.

ECONOMIC ISSUES IN THE CHOICE OF COMPENSATION ARRANGEMENTS FOR INTERCONNECTION BETWEEN LOCAL EXCHANGE CARRIERS AND COMMERCIAL MOBILE RADIO SERVICE PROVIDERS

Prepared for:

CELLULAR TELECOMMUNICATIONS INDUSTRY ASSOCIATION

Prepared by:

CHARLES RIVER ASSOCIATES

Steven R. Brenner
Bridger M. Mitchell

March 4, 1996

I. Introduction

As the Commission long has been aware, arrangements for interconnection between communications networks make a critical difference in the level of service new carriers can offer to consumers. This is true regardless of whether new carriers offer service that extends and complements the services of established carriers, or offer a substitute for service by established carriers. Where new carriers offer a substitute, technical and compensation arrangements for interconnection between new and established carriers that do not disadvantage new carriers also are critical for the development of competition and for realizing the benefits of competition.

The recent *Notice of Proposed Rulemaking* in CC Dockets Nos. 95-185 and 94-54 (the "*Notice*")[1] addresses interconnection arrangements between local exchange carriers (LECs) and commercial mobile radio service ("CMRS") providers. As the Commission notes, these arrangements assume increased importance in light of the prospect of competition between CMRS providers and LEC wireline services.[2] The *Notice* first questions whether private negotiations without regulatory oversight of terms and conditions are likely to yield interconnection agreements in the public interest.[3] It then explores various types of compensation arrangements, including several payment structures as well as bill and keep arrangements.

This paper identifies and analyzes economic issues that bear on the choice among compensation arrangements for interconnection. The next section discusses negotiated agreements and analyzes the threshold issue of whether regulatory oversight is desirable. This section discusses the economic forces that can be expected to influence the result of negotiated settlements, and the economic effects of the likely agreed-upon arrangements. If these agreements are instead to be subject to regulatory oversight of some sort, policy choices must be made among compensation arrangements. The remaining sections of this paper frame and analyze economic issues that bear on this choice. Section III

[1] Released January 11, 1996.

[2] See *Notice* at ¶2.

[3] *Notice* at ¶¶8-14.

analyzes the cost recovery characteristics of bill and keep and usage sensitive payment arrangements. Section IV identifies three ways in which the choice of compensation arrangements may affect economic efficiency; these are analyzed in the following three sections. Section V analyzes the efficiency of price signals resulting from usage sensitive pricing and bill and keep arrangements. Section VI discusses the effects of compensation arrangements on transactions costs. Section VII discusses how the choice of compensation arrangements can affect competition and dynamic efficiency. Section VIII concludes.

The analysis reaches the following primary conclusions:

- Because of the unequal bargaining positions of CMRS providers and LECs, and because of the incentive of the LECs to use the pricing of interconnection service to extend or protect their market position, negotiations between LECs and CMRS providers that are unconstrained by regulatory rules or controls are unlikely to yield efficient interconnection compensation arrangements that are in consumers' interests.
- Carriers do not receive interconnection services for free under bill and keep arrangements. Each carrier incurs a cost obligation in exchange for the interconnection services it receives from the other carrier, because each receives termination services only in exchange for providing termination services for the other carrier.
- Whether, under bill and keep, carriers bear costs equal to the cost of interconnection services provided to them depends not on whether total traffic flows between interconnected carriers are equal, but on (a) the amount of traffic each carrier receives for termination during its system busy hour, and (b) the capacity cost per minute that each carrier incurs to terminate that busy hour traffic.
- A choice among compensation arrangements should consider not only the efficiency of price signals under each arrangement but also the effects of compensation arrangements on the costs of monitoring, billing, and collecting payments for services provided, and on the development of competition and dynamic efficiency.
- A choice between bill and keep and usage sensitive pricing should not be based on the simple argument that because the costs of interconnection are

usage sensitive, usage sensitive prices are therefore efficient and bill and keep is inefficient. This argument ignores the effects of compensation arrangements on costs and dynamic efficiency, and is an incomplete analysis of the efficiency of pricing signals under both bill and keep and usage sensitive pricing arrangements.

- Costs of dedicated circuits connecting CMRS and LEC networks should not be recovered with usage sensitive prices, but by capacity-based charges or other arrangements for sharing the costs of that capacity.
- The costs of shared network facilities used to terminate interconnected traffic are fundamentally costs of increasing capacity, and only additional terminating traffic that requires increases in capacity imposes a cost.
- Neither a bill and keep nor a usage sensitive pricing arrangement sends fully optimal price signals. Because the prices that in theory would be fully optimal will not be feasible in practice, it will be necessary to choose among arrangements with less than fully optimal price signals.
- Bill and keep arrangements set a price of zero for sending additional traffic for termination. A price of zero is optimal for the substantial volume of interconnected traffic that imposes no capacity costs, but is too low for traffic during the busy hour, or more generally for traffic that does impose capacity costs on the terminating carrier.
- A uniform price per minute, even if set no higher than the average cost per minute of terminating traffic, will be too high to send efficient pricing signals for traffic that does not impose capacity costs, and too low to send efficient pricing signals for most or all traffic that does impose capacity costs.
- Peak/off-peak pricing also will not send fully efficient price signals since, for one portion of the peak period, prices likely will be too high to send efficient pricing signals, and for all or most of the balance of the peak period prices will be too low to send efficient pricing signals.
- Without detailed demand and cost information, it is not possible to conclude that price signals will be more efficient with either a uniform price or a peak/off-peak price structure than with a bill and keep arrangement.
- Usage sensitive compensation arrangements will impose higher transactions costs to track and bill usage than will bill and keep arrangements.

- High prices for interconnection will increase the cost of serving a subscriber far more for CMRS providers than for LECs. and therefore excessive prices will sharply limit the ability of CMRS providers to provide competition for LEC service.
- The risk of hindering competition and reducing dynamic efficiency is greater with usage sensitive compensation arrangements than with bill and keep arrangements. because the risk of setting excessive prices for interconnection service is greater with usage sensitive compensation arrangements.

II. Negotiated Agreements

All carriers have incentives to minimize the costs of interconnection agreements. Carriers that neither have nor can expect to gain market power are likely to negotiate interconnection agreements that minimize both the costs of the interconnection arrangements themselves and the transactions costs associated with their agreement. By reducing costs of carrying interconnected traffic, and of measuring and billing for such traffic, firms gain the advantage of lower total costs than they would have with a less efficient interconnection agreement. Furthermore, the individual carriers will be well placed to reach efficient contracts because they will have good information about the relative costs of different technical and billing arrangements.

The tendency for privately negotiated contracts to have efficient properties depends crucially, however, on the two carriers having similar bargaining power, and on neither carrier being able to use the transaction to maintain or increase its market power. Neither condition is likely to hold when LECs and CMRS providers negotiate interconnection arrangements. A LEC typically has a much stronger bargaining position than a CMRS provider and possesses the ability to maintain or extend its market power through the terms of the agreement.

To offer its customers the ability to call and be called by LEC subscribers, a CMRS provider must acquire an essential input from the LEC: interconnection services. Of course, the LEC also needs interconnection service from the CMRS provider in order to allow its customers to place calls to or receive calls from CMRS subscribers. Thus, interconnection is valuable to both LECs and CMRS providers, but that does not mean it

is equally valuable. A simple numerical example illustrates some of the basic asymmetries between the two types of providers.

For this example, assume there is a total of 100 subscribers, with 90 subscribers to LEC service and 10 subscribers to CMRS service. Further, assume that each subscriber is equally likely to call each other LEC or CMRS subscriber in any given period of time.[4] If each subscriber calls every other subscriber exactly once each month it is easy to calculate the amount of calling that is made possible by interconnection.

The calculations are summarized in Table 1. Each subscriber places and receives a total of 99 calls. However, there is a striking difference in the number of interconnected calls made and received by a LEC subscriber and by a CMRS subscriber. A CMRS subscriber makes 90 calls to LEC numbers and only 9 to CMRS numbers, and also receives 90 calls from LEC subscribers and 9 from CMRS subscribers. Just over 90 percent of calls for a CMRS subscriber depend on interconnection. This pattern is reversed for a LEC subscriber, with only about 10 percent of calling depending on interconnection: Just 10 of the 99 calls placed and 10 of the 99 received are to or from CMRS subscribers, while there are 89 calls to other LEC subscribers and 89 calls from other LEC subscribers.[5]

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[4] In this example, there is no asymmetry or imbalance in calling that is due, for example, to CMRS subscribers not wanting to call other CMRS numbers but only LEC numbers, or to LEC subscribers being uninterested in calling CMRS subscribers or being unable to complete calls to CMRS subscribers.

[5] Note, however, each network terminates exactly the same volume of interconnected calls so that the traffic flows are balanced. Each of 10 CMRS subscribers places 90 calls to LEC numbers, a total of 900 calls, while each of 90 LEC subscribers places 10 calls to CMRS numbers, again a total of 900 calls.

Table 1
An Example of Interconnected Traffic Flows

Assumptions For the Example

100 Total Subscribers
90 subscribers to the LEC
10 subscribers to the CMRS provider

Each subscriber calls every other subscriber once each month

Calls per Month

Each CMRS Subscriber			
Calls to LEC subscribers	90	Calls from LEC subscribers	90
Calls to CMRS subscribers	9	Calls from CMRS subscribers	9
Total calls made	99	Total calls received	99
Each LEC Subscriber			
Calls to LEC subscribers	89	Calls from LEC subscribers	89
Calls to CMRS subscribers	10	Calls from CMRS subscribers	10
Total calls made	99	Total calls received	99

Total Calls Terminated

By the CMRS Provider:
90 calls per CMRS subscriber x 10 subscribers = 900 calls

By the LEC:
10 calls per LEC subscriber x 90 subscribers = 900 calls

A consumer's decision to subscribe to a service depends on the value expected from both placing and receiving calls.[6] The example illustrates how, for CMRS providers, a high proportion of calling and thus of the value of their service to consumers depends on interconnection with the LEC network. A much smaller proportion of the calling for LEC subscribers, and thus much less of the value of LEC service to a subscriber, depends on interconnection to the CMRS provider. As a result of this

[6] More formally, the demand for access (subscription) depends on the consumer surplus received from both originated and received calls, after taking into account charges for usage. See L. Taylor, *Telecommunications Demand in Theory and Practice*, Kluwer, Dordrecht, 1994.

asymmetry, the LEC can expect to be in a far stronger bargaining position. The LEC "needs" interconnection less than the CMRS provider. and can far more credibly threaten to "walk away" from the bargaining table if it doesn't get what it wants. By charging CMRS providers a high price for interconnection. the LEC can use its market power over this input to extract supracompetitive profits from downstream markets in which CMRS services are sold. The imbalance of bargaining power indicates that LECs likely will be able to exercise such market power.

When CMRS providers and LECs compete downstream in the supply of retail telecommunications services, a second economic factor will affect the outcome of negotiated interconnection agreements. LECs likely will have an incentive to disadvantage the competing CMRS provider in order to increase or preserve the market power they can exercise in downstream markets.[7,8] Forcing the CMRS provider to pay still more for interconnection reduces the competitive pressure the CMRS provider can exert on the LEC in downstream markets; in the extreme high interconnection charges could drive CMRS competitors out of business.[9] The result is less downstream competition from which consumers can benefit. The potential for disadvantage is clear if

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[7] As is well known, under the right conditions an upstream supplier with monopoly control of an input can capture monopoly profits as effectively as if it had a downstream monopoly. In such cases it has no incentive to acquire a monopoly downstream. The conditions necessary for this result include that the input is used in fixed proportion to output, that the downstream market is perfectly competitive, and that there are no regulatory constraints on the input price. See for example, Michael H. Riordan and Steven C. Salop, "Evaluating Vertical Mergers: A Post-Chicago Approach," *Antitrust Law Journal*, Vol. 63, No. 2 (Winter 1995). It is unlikely that all the necessary conditions are satisfied in this case.

[8] A LEC need not be pricing local services above its own costs, and in particular need not be pricing to recover revenue in excess of accounting costs, in order to have an incentive to disadvantage rival CMRS providers. LECs could have such a incentive so long as competition from the rival would, with lower interconnection prices, reduce or constrain LECs' pricing and/or the net revenue they can earn in the downstream market. Such pressure on LEC prices and/or net revenues might result from rivals simply being able to offer lower prices that LECs must match to avoid losing market share, or from rivals offering service of superior quality that LECs must match or offset with lower prices to avoid losing market share.

[9] LECs may also be able to disadvantage rival CMRS providers through non-price as well as price terms.

the LEC can charge CMRS providers more per call or per minute of use to terminate calls on the LEC network than the LEC pays for termination by the CMRS provider.[10]

Even if a LEC must pay the same price for termination that it charges a CMRS provider, it still may be able to disadvantage a competing CMRS rival. When CMRS providers are just beginning to compete with LECs, termination on the other network is likely to be a more important input per subscriber and to account for a larger proportion of costs for CMRS providers than for LECs (as in the example above). Even if both pay the same price for termination, an increase in that price raises costs per subscriber more for the CMRS provider than for the LEC, and thus disadvantages the CMRS provider relative to the LEC.

Because of the unequal bargaining positions of the parties, and because of the incentive of LECs to use pricing of interconnection service to extend their market power, this analysis suggests that private, unconstrained negotiations between LECs and CMRS providers are unlikely to yield efficient interconnection compensation arrangements that are in consumers' interests. Many existing interconnection arrangements between cellular providers and LECs have been the result of negotiations subject to little or no regulatory oversight. The CTIA has collected information from members on what they pay LECs for terminating traffic, and on what (if anything) they are paid to terminate LEC-originated calling. The information collected is consistent with the analysis here. All of the cellular systems responding to this question reported that they must pay LECs to terminate traffic originated by cellular subscribers. Few cellular systems, however, receive compensation for terminating calls placed by LEC subscribers; only 10 percent of members' responses indicate that they receive any compensation from LECs for terminating LEC-originated traffic -- despite the FCC policy requiring mutual compensation.[11] Several cellular systems reported that they not only failed to receive compensation, they in fact had to *pay* the LEC for LEC-originated traffic.

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[10] If termination costs differ for the two networks, there would be a disadvantage if the markup of price over cost is greater for calls terminated by the LEC.

[11] The reported figure of 10 percent is in fact something of an overstatement. Each of the responses indicating compensation was received is the response of a cellular operator providing

If compensation arrangements for interconnection are not to be left to unconstrained private negotiations, policy choices must be made among alternative ways of structuring and setting the level for compensation. The remainder of this paper discusses issues raised by such choices. The next section discusses whether and how various compensation arrangements allow carriers to recover the costs the incur as a result of interconnection. The remaining sections discuss the impact on economic efficiency of the structure and level of rates under various compensations arrangements.

III. Recovery of Costs

Two interconnected carriers will each incur costs to handle traffic originated on one network and terminated on the other. Most of these costs will be incurred to terminate traffic originated on the other's network. Other interconnection-related costs include those of the trunks connecting the two networks, and monitoring, billing and accounting costs. The first characteristic of compensation arrangements to be evaluated is whether they allow for the recovery of such costs. Does each carrier, as a result of the interconnection agreement, incur an obligation to pay the additional costs incurred to handle interconnected traffic? This section discusses the cost recovery characteristics of usage sensitive payments and bill and keep compensation arrangements.

A. Recovery of Costs with Usage Sensitive Payments

LECs and CMRS providers have a direct means for recovering the cost of terminating traffic originated by the other if the compensation arrangement specifies that each will make payments tied to the volume of terminated traffic. Whether those payments are adequate to cover the costs incurred, both now and in the future, will depend on the level and structure of the usage sensitive rates. Rate level and rate structure issues are discussed in more detail in subsequent sections, but the basic implications for cost recovery are straightforward.

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information for multiple systems, and each response indicates that compensation is received for only *some* of the systems covered by the response.

If the volumes of interconnected traffic were constant, it would be a simple matter, in principle, to determine rates per unit of traffic that would recover those costs. First, determine the level of costs per billing period that each carrier incurs to terminate traffic originating on the network of the other, and then divide by the number of units of traffic terminated in the billing period.[12] Charging this rate will yield revenues equal to the costs used to calculate the rate, so long as traffic volumes do not change. Of course, in practice traffic volumes will change over time, both because the rate the other carrier pays for interconnection and includes in retail prices will affect consumers' usage, and because traffic can be expected to change over time with changes in the number of subscribers to each network and with the overall growth in demand for various types of local service.

Whether, in the face of changing traffic, a given set of rates will continue to generate revenue equal to, or greater than, the costs incurred, will depend on how closely the structure and level of rates match the structure and level of costs. When traffic increases, revenue will grow more rapidly than cost if there is a uniform charge per minute of terminated traffic and the cost of terminating traffic does not increase at the same rate as traffic. Conversely, with this structure of rates and costs a reduction in traffic would cause revenue to fall more rapidly than cost.

The structure of usage sensitive rates almost certainly will diverge from the structure of costs if such rates are used to recover costs that do not depend directly on the level of usage. Even for rates used to recover only usage-sensitive costs, revenue and cost may diverge over time. Costs may vary with usage without varying in proportion to total traffic. Later sections of this paper discuss the impact of rate structure and level on overall economic efficiency. The point here is that differences between the structure of rates and the structure of costs can, over time, lead to growing differences between the revenue a carrier recovers and the costs it incurs.

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[12] The derivation of rates from costs is discussed in more detail below.

B. Recovery of Costs Under Bill and Keep

If a LEC and a CMRS provider interconnect under a bill and keep arrangement, neither makes any payments to the other. Instead, each carrier must cover the cost of handling interconnected traffic by billing its own customers and keeping the revenue. It is often observed that when traffic flows between the carriers are balanced the net flow of revenue between carriers is the same under both a bill and keep system and under uniform usage payments. This is a useful and significant observation. A more complete comparison of bill and keep and usage sensitive payments, however, requires an analysis of the costs the two providers incur to handle interconnected traffic, and the obligations each incurs to pay for those costs.

1. LEC and CMRS Cost Obligations

Calling bill and keep a compensation arrangement may seem a misnomer as neither the LEC nor the CMRS provider makes payments to compensate the other for costs incurred. This does not mean, however, that either carrier receives interconnection services for free. The LEC and the CMRS provider each incur a cost obligation in exchange for the interconnection services they receive from the other. Bill and keep is part of a mutual obligation to terminate traffic from the other. The CMRS provider receives termination services from the LEC only in exchange for providing, and bearing the costs of providing, termination services for LEC-originated traffic. The LEC likewise receives termination services from the CMRS provider in exchange for providing similar services for CMRS-originated traffic.

Under bill and keep each provider incurs a cost obligation in exchange for receiving interconnection services from the other. However, its costs may, or may not, be equal to what it costs the other provider to provide interconnection services. Under bill and keep, when each provider must incur approximately the same costs to supply interconnection services to the other, the cost a provider incurs will equal the cost of the service it receives.

2. *Balance of Traffic*

Is balance in the traffic flows between a LEC and CMRS provider equivalent to a balance in the costs of supplying interconnection services? This is not necessarily the case. The traffic flows in each direction need not be equal for each provider to bear costs approximately equal to the cost of interconnection services they receive, nor are equal traffic flows sufficient to insure that the costs are equal. Equality of overall traffic flows between the providers is neither necessary nor sufficient for equality of costs because the impact of traffic on cost varies with the time of day, and because LEC and CMRS networks may incur different costs per unit of terminated traffic.

The "usage-sensitive" costs of terminating traffic in a LEC or CMRS network arise from the need to provide sufficient network capacity to carry any additional traffic that is terminated during the busy hour in that network. Each network's switching and transport facilities are sized to provide a specified grade of service at the busy hour. Once each network has been constructed, nearly all of the incremental costs of carrying additional traffic are due to expanding capacity. Because the principal costs of terminating traffic are capacity costs, the hourly distribution through the day of terminating traffic is central to determining the effect of terminating traffic on network costs. The volume of traffic delivered during the *terminating* network's busy hour will determine the costs of providing terminating interconnection services, since this traffic will affect the capacity needed by the terminating network.[13] Terminating traffic delivered outside the busy hour will have little effect on needed capacity and therefore little effect on costs. Thus, it is the balance in the amount of traffic delivered to each provider during its busy hour that will affect costs rather than the balance of overall traffic.

The balance of overall traffic could, for a variety of reasons, differ substantially from the balance of traffic delivered during the terminating carrier's busy hour. The hypothetical examples summarized in Table 2 illustrate two reasons the patterns could

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[13] This is something of a simplification since not all network facilities necessarily have the same busy hour.

differ. In Case A, both the LEC and CMRS provider have the same busy hour, and both deliver 100 units of traffic to the other during that busy hour. The time profile of LEC-originated and CMRS-originated calling differ, however. Over a 24-hour period total LEC-originated, interconnected traffic is 8 times the amount of traffic in the busiest hour for such traffic, while total CMRS-originated, interconnected traffic is 12 times the amount in the busiest hour. As a result, the LEC terminates 1200 units of total traffic during a 24-hour period, while the CMRS provider terminates a total of 800 units. Despite this imbalance in total traffic, each provider terminates the same amount of traffic during the terminating system's busy hour, suggesting that each much provide

Table 2
Balance of Traffic:
Total Traffic and Traffic Imposing Capacity Costs

	Direction of Traffic	
	CMRS to LEC	LEC to CMRS
Hypothetical Case A		
Terminating system busy hour (BH)	11am	11am
Terminating traffic in terminating system BH	100	100
Ratio of total interconnected traffic to BH traffic	12	8
Total 24- hour interconnected traffic	1200	800
Hypothetical Case B		
Terminating system busy hour (BH)	11am	4pm
Terminating traffic in terminating system BH	100	100
Maximum volume of traffic in any hour	125	100
Ratio of total interconnected traffic to max. hourly traffic	10	10
Total 24- hour interconnected traffic	1250	1000

approximately the same increment in overall capacity to handle interconnected traffic.

The hypothetical of Case B illustrates another possible source of difference: non-coincident busy hours for the two networks with interconnected traffic. In Case B, the LEC and CMRS provider again each receive 100 units of traffic for termination during their system busy hour. Now, however, the two networks have different system busy